

Hess's Law

Advanced Chemistry

Introduction

- ▶ It is often possible to calculate ΔH for a reaction from the tabulated ΔH values of other reactions.
 - ▶ Thus, it is not necessary to make calorimetric measurements for all reactions.

Enthalpies in Reactions

- ▶ Because enthalpy is a state function, the enthalpy change, ΔH , associated with any chemical process depends only on the amount of matter that undergoes change and on the nature of the initial state of reactants and final state of products.
 - ▶ Whether a reaction is carried out in one step or in a series of steps, the sum of the enthalpy changes associated with individual steps must be the same as the enthalpy change associated with a one-step process.

Hess's Law

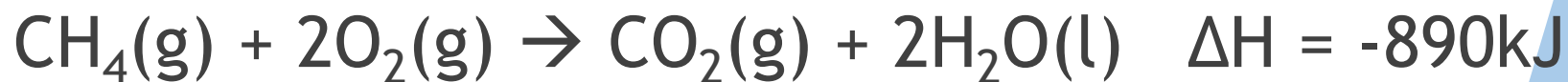
- ▶ Hess's Law states that if a reaction is carried out in a series of steps, ΔH for the overall reaction equals the sum of the enthalpy changes for the individual steps.

3 Guidelines When Using Thermochemical Equations

1. Enthalpy is an extensive property.

- ▶ The magnitude of ΔH is proportional to the amount of reactant consumed in the process.

Example: 890 kJ of heat is produced when 1 mole of CH_4 is burned in a constant-pressure system:



- ▶ Because the combustion of 1 mol of CH_4 with 2 mol of O_2 releases 890 kJ of heat, the combustion of 2 moles of CH_4 and 4 moles of O_2 releases twice as much heat, 1780 kJ

3 Guidelines When Using Thermochemical Equations

2. The enthalpy change for a reaction is equal in magnitude, but opposite to sign to ΔH for the reverse reaction.



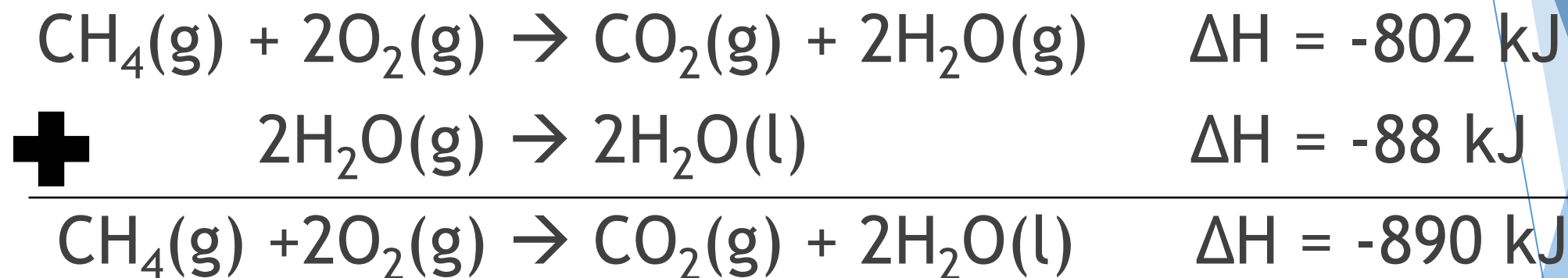
3 Guidelines When Using Thermochemical Equations

3. The enthalpy change for a reaction depends on the states of the reactants and products

- ▶ If the product from equation were $\text{H}_2\text{O}(\text{g})$ instead of $\text{H}_2\text{O}(\text{l})$, ΔH_{rxn} would be -802 kJ instead of -890 kJ .
- ▶ Less heat would be available for transfer to the surroundings because the enthalpy of $\text{H}_2\text{O}(\text{g})$ is greater than that of $\text{H}_2\text{O}(\text{l})$
- ▶ In other words



Example



*Compounds on opposite sides of arrows are subtracted, while objects on same side are added.

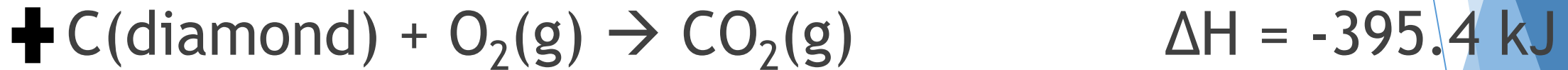
Example

- ▶ The enthalpy of reaction for the combustion of C to CO₂ is -393.5 kJ/mol C, and the enthalpy for the combustion of CO to CO₂ is -283.0 kJ/mol CO:

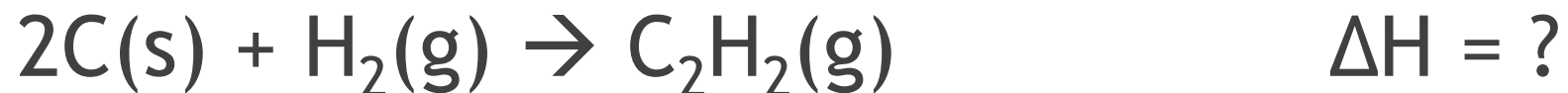
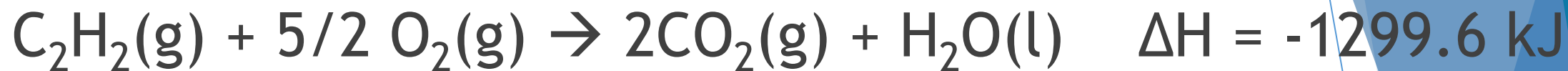


More Practice

- ▶ Carbon occurs in two forms, graphite and diamond. The enthalpy of the combustion of graphite is -393.5 kJ/mol, and that of diamond is -395.4 kJ/mol:



More Practice



Practice

